GAMMA RAY BRANCHES IN THE DECAY OF Cu^{64} AND Ti^{45}

BY

HERBERT ERNEST KUBITSCHEK

S.B., University of Chicago, 1942
M.S., University of Illinois, 1947

AN ABSTRACT OF A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
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Introduction

The measurement of nuclear gamma rays from positron emitters by absorption techniques is complicated by the annihilation radiation given off in the absorption of positrons: intensities of the order of magnitude of the .51 Mev annihilation radiation are required to distinguish gamma rays of quite different energies, while energies close to .5 Mev are always inseparable.

This work presents the development of an absorption method which permits the determination of these gamma ray energies ordinarily obscured by annihilation radiation. The method consists of placing the source, which must be thin to self-absorption of positrons, in a vacuum chamber. Positrons then leave the source to annihilate at the chamber walls, from which radiation the counter can be shielded. The nuclear gamma radiation is then measurable by the customary technique of absorption in lead. Accuracy requires a calibrated geometry.

Applicability of the method is shown a) in the detection of the known gamma ray from Cu^{64}, and b) in its utilization to find the hitherto unknown gamma rays from Ti^{45}.

Discussion Of Results

The energy of the gamma ray from Cu^{64} was determined with the use of a 0.1 mil copper foil. The result was $1.42 \pm .06$ Mev. The number of positrons emitted per gamma was found to be 31 ± 5. Both of these values are in reasonable agreement with the work of Deutsch (1).

Two gamma rays were found in the decay of Ti^{45} with energies of $.82 \pm .03$ Mev and $.51 \pm .02$ Mev. The ratios of the number of positrons to .5 Mev gamma rays to .8 Mev

gamma rays is

$$(19 \pm 2) \ : \ (4.1 \pm .8) \ : \ (1)$$

Verification was obtained for both the .8 Mev and the .5 Mev gamma rays by means of gamma ray spectroscopy, through the generation of secondary electrons in a uranium converter. From the Compton and photoelectron lines the higher energy was measured as $.80 \pm .01$ Mev. The lower energy of $.48 \pm .02$ Mev was observed by its contribution to a marked asymmetry on the low energy side of the K and L lines from the annihilation radiation.

Additional evidence for the gamma rays was obtained by showing, via critical absorption techniques, that K capture takes place with the subsequent emission of scandium X-rays.

The half-life for Ti^{45} was measured to be $3.09 \pm .03$ hours, in agreement with Allen, Pool, Kurbatov, and Quill (2).

The positron maximum energy for the transition was also measured with the spectrometer. A Kurie plot (3) gave $1.00 \pm .02$ Mev, which differs appreciably from the cloud chamber value found by Allen, *et al.* The *ft* (4) values for both positron emission and K capture indicates the transitions are allowed.

The relative yield was obtained for the reaction $Ti^{46}(\gamma,n)Ti^{45}$ to that of $Ti^{48}(\gamma,p)Sc^{47}$ using gamma rays from the 22 Mev betatron. The yield of the former was found to be 5.3 times greater than that of the latter.

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VITA

Herbert E. Kubitschek was born in Oak Park, Illinois on June 9, 1920. He attended the University of Chicago from October, 1938 to June, 1942. During his attendance there he received an Honorable Mention for Work in the College, and received the Bachelor of Science degree with a major in physics in March, 1942.

From June, 1942 to February, 1946 he was employed by the Manhattan District at the University of Chicago and Argonne Laboratory. During these years he was engaged in experimental research in nuclear physics. Publications from the work of this period include "Capture Gamma Ray Studies" by H. E. Kubitschek and S. M. Dancoff, Phys. Rev., 76, 531 (1949) ; "Boron Absorption of Resonance Activation," by Dancoff, *et al,* Publication No. 639 by the A. E. C.; and "Activation Cross Sections by Boron Absorption," by Dancoff, *et al,* Publication No. 1781 by the A. E. C.

From February, 1946 to September, 1949 he was a student in the Graduate College of the University of Illinois. He was employed from 1946 to 1948 first as a research assistant and later a teaching assistant. He received the degree of Master of Science in January, 1947. The spring semester of 1948 he was a University of Illinois Fellow, and from September, 1948 until September, 1949 he was an A. E. C. Predoctoral Fellow.

He is a member of Sigma Xi and is also associated with the American Physical Society.

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